Non-concatenative Morphology*

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1 Introduction

While morphological processes and representations across human language have been argued to be underwritten by a comparatively small number of theoretical mechanisms within the framework of Distributed Morphology (Halle and Marantz, 1993; 1994; Harley and Noyer, 1999; Embick and Noyer, 2001), one place where this theoretical reduction is not so empirically obvious concerns the difference between so-called concatenative and non-concatenative morphology. Whereas the majority of the world's languages involve morphological processes which are CONCATENATIVE and involve linear affixation of material to a base which remains relatively unperturbed, languages such as Hebrew, Arabic, Maltese, and Yolumnwe have morphological processes which are NON-CONCATENATIVE and involve morphological material from both the base and affix interleaved in non-trivial ways. Examples of this distinction are shown for concatenative plural formation in (1) and non-concatenative plural formation in (2):

(1) Concatenative Plural Formation:

a. gato ~ gato-s
cat ~ cat-PL
"Cat ~ cats" (Spanish)

b. Hund ~ Hund-e
dog ~ dog-PL
"Dog ~ dogs" (German)

(2) Non-concatenative Plural Formation:

a. ʃeex ~ ʃujuux
sheikh ~ sheikh.PL
"Sheikh ~ sheikhs" (Arabic)

b. ʤakketta ~ ʤiɛket
jacket ~ jacket.PL
"Jacket ~ jackets" (Maltese)

Non-concatenative morphology (NM, henceforth) poses several non-trivial challenges for theoretical approaches to morphology, especially those which take morphosyntax to be fundamentally concatenative in nature, such as Distributed Morphology. In this chapter, we review the empirical and theoretical challenges associated with NM and suggest that the prevailing analytical consensus correctly identifies NM as the emergent output of a combination of concatenative syntax and language-specific phonological processes/constraints.

*It is difficult to gauge where our understanding of non-concatenative morphology would be without Edit Doron, who sadly passed away while this chapter was being written. We hope it serves as a tribute to her lasting influence and conjures up happy memories for those who were lucky enough to know her.

As the name implies, the major challenge in theories of NM is understanding the theoretical nature of non-concatenative affixation. This is true of any generative account of NM, but is especially acute in theories like Distributed Morphology which assume that morphology is underwritten by syntactic operations which are purely local and concatenative. Moreover, the existence of NM in general suggests that morphological representation can be quite abstract — the empirical generalizations over NM which are easiest to state require positing morphological objects which are never seen contiguously in isolation, such as triconsonantal roots. Even worse, ascribing semantic content to such abstract units has, as we shall discuss, been a particularly vexing problem for generative grammar. Finally, we will show that much prior work on NM-containing languages has shown that there is a strong correlation between the presence of NM and stricter-than-average phonotactic or prosodic constraints on word formation. NM, therefore, also implicates the boundaries between morphology, phonology, and syntax.

In our view, any explanatorily adequate theory of NM must be able to answer the following questions:

(3) The Central Questions of NM:

a. How can morphemes/morphological material be realized discontinuously in surface forms?

b. What are the primitives units of word formation? Do NM-containing languages require idiosyncratic primitive units?

c. Does the "lexicon" contain purely abstract elements such as consonantal roots?

d. What is the role of phonotactics and prosody in NM word-formation?

e. Where are the boundaries between idiosyncratic and compositional semantic interpretations in languages with NM?

Our survey of the theoretical landscape in work on NM will build toward the view that there is very little that is special about non-concatenative morphology — that in fact, NM is actually expected if one allows the prevailing ideas about Distributed Morphology-inspired morphosyntax to freely interact with current views of linearization and/or prosodic morphology. Specifically, we suggest the following loose consensus from the literature on NM:

(4) THE CURRENT NON-CONCATENATIVE CONSENSUS:
Non-concatenative morphology is not grammatically special except that it involves a particular combination of modular interactions that allow for non-concatenative phonology.

There are two ways of cashing out this notion. In DM, this understanding of NM crucially relies on (i) a DM-style partition of the "lexicon" into lexical roots and syntactic heads, and (ii) cyclic spell-out combined with linearization accounts which allow non-concatenativity. However, the conclusion in (4) is also shared by other theories, such as Bat-El's lexicalist theory and Borer's Exo-Skeletal model, in which case other assumptions come into play. All major contemporary theories of NM attempt to understand the central questions in (3) through the lens of (4). In this chapter we will focus on DM's particular non-lexicalist account of NM, though many of the pre-theoretical generalizations we draw out are formulable in other theories, as well (see the chapter on Exo-Skeletal approaches, especially).

While NM exists in many languages and is by no means a language-family specific phenomenon, the Semitic language family appears as the central object of study in theoretical work

because of its large number of speakers and widespread use of NM in both the nominal and verbal domain.[1] Accordingly, we focus the majority of the empirical exegesis in this chapter in §2 on Semitic, specifically Hebrew and Arabic, followed by an overview of DM analyses in §3. Other languages are then discussed in §4. We conclude with some discussion of the potential future of DM work on non-concatenative morphology in §5.

2 Semitic morphology

In this section we review the major descriptive empirical generalizations which require analysis in Semitic (§2.1) as well as the theoretical claims concerning these generalizations made in approaches prior to the advent of Distributed Morphology (§2.2).

2.1 Descriptive Generalizations

NM in Semitic expresses itself in both the nominal and verbal domain. In the verbal domain, the patterns of NM result in descriptive treatments which revolve around three distinct representational components: (i) a CONSONANTAL ROOT made up of 2-4 consonants, (ii) a set of vowels which interleave between the root consonants, and (iii) a CV-SKELETON which defines the pattern of arrangement for the first two elements. In addition to (i–iii), affixal material (usually additional consonants) can also appear, both concatenatively and non-concatenatively. The result is a series of verbal TEMPLATES which form the core of derivational verbal morphology in Semitic. In Hebrew, this gives rise to seven verbal templates, shown in (5). In Modern Standard Arabic — the variety of Arabic with the richest verbal system — this gives rise to ten verbal templates, shown in (6).[2]

(5) The Hebrew Verbal Patterns:

CV-Skeleton	*Example*	*Translation*
XaYaZ	gadal	"he grew"
niXYaZ	nirdam	"he fell asleep"
XiY̱eZ	gidel	"he raised"
XuY̱aZ	gudal	"he was raised"
hitXaY̱eZ	hitkabel	"he was received"
hiXYiZ	higdil	"he enlarged"
huXYaZ	hugdal	"he was enlarged"

[1] In this chapter we generally treat Maltese as though it were Arabic, an oversimplification which borders on erroneous. This simplification is in part undermined by the fact that the NM system has eroded considerably in Maltese; see Borg and Azzopardi-Alexander (1997) and Spagnol (2011) for discussion of the NM system in this language.

[2] Some notational matters are in order. Templates are sometimes referred to by their Hebrew grammatical name, *binyanim*, by their Arabic name, *awzaan*, or as *forms*, *measures* or *patterns*; we keep the latter as a general term. The citation form of Semitic verbs is 3SG.M.PAST. In the Hebrew and Arabic grammatical traditions, CV-Skeletons are referred to using a the roots $\sqrt{\text{pʕl}}$ and $\sqrt{\text{fʕl}}$, respectively, along with the most common vowels found in the perfective aspect; we use XYZ (following Kastner, 2016) in order to abstract away from the specific language under discussion — in all cases X, Y, and Z refer to the first, second, and third root consonants, respectively. These patterns are described relative to triconsonantal roots with so-called strong roots that do not contain a semivowel. While Arabic has preserved gemination ("YY"), certain Modern Hebrew templates no longer geminate but instead block a language-specific process of spirantization. We borrow the non-syllabic diacritic Y̱ to indicate this but do not discuss this point further as it is specific to Hebrew; see Kastner (2017; 2018).

(6) The MSA Verbal Patterns:

CV-Skeleton	*Example*	*Translation*
XaYaZ	katab	"he wrote"
XaYYaZ	kattab	"he made someone write"
XaaYaZ	kaatab	"he corresponded"
ʔaXYaZ	ʔaktab	"he dictated"
taXaYYaZ	takassar	"he broke"
taXaaYaZ	takaatab	"he wrote (reciprocal)"
inXaYaZ	inkatab	"he subscribed"
iXtaYaZ	iktatab	"he copied"
iXYaZZ	iswadd	"he became black"
istaXYaZ	istaktab	"he asked someone to write"

While patterns like those in (5–6) exist in other languages (e.g., English strong roots such as *sing~sang~sung~song*), what makes Semitic morphology peculiar from a typological perspective is that patterns like these are the rule rather than the exception (although cf. Schwarzwald 2016 on some innovations in Hebrew and Spagnol 2011 on Maltese). All verbs in Semitic languages appear in one of the patterns in (5–6), where the core idiosyncratic lexical meaning of the verb is carried largely by the consonantal root. In (5) the root is $\sqrt{\text{gdl}}$, $\sqrt{\text{rdm}}$, or $\sqrt{\text{kbl}}$, whereas in (6) the root is $\sqrt{\text{ktb}}$, $\sqrt{\text{ksr}}$, or $\sqrt{\text{wd}}$.

In addition to these non-concatenative patterns exemplified in (5–6), Semitic languages also have segments of their morphology which are concatenative; typically in places outside of verbal derivational morphology. In both Hebrew and Arabic, inflectional morphology associated with syntactic subject-verb agreement is largely concatenative — while ablaut is possible in the some tenses/aspects (7), the root consonants and their templatic realizations are left relatively undisturbed and perfective forms are universally concatenative with no ablaut.[3]

(7) Arabic Subject-Verb Agreement is Concatenative:

PERS.GEN	SG	PL
1	**a-**ktub	**na-**ktub**-u**
2m	**ta-**ktub**-u**	**ta-**ktub**-uuna**
2f	**ta-**ktub**-iina**	**ta-**ktub**-na**
3m	**ya-**ktub**-u**	**ya-**ktub**-uuna**
3f	**ta-**ktub**--u**	**ya-**ktub**-na**

Moreover, many varieties of Arabic express sentential negation with a freestanding particle /laa/ or more importantly a circumfix /ma-...-(ʃ)/ as in (8):[4]

(8) Arabic Negation is Circumfixal:

a. a-fham ⟶ laa a-fham
1S-understand ⟶ NEG 1S-understand
"I understand ⟶ I do not understand" (MSA)

b. ktəb ⟶ ma-ktəb-ʃ
write.3S ⟶ NEG-write.3S-NEG

[3]This data is from Modern Standard Arabic and comes from Ryding (2005), though the facts are similar for all spoken varieties of Arabic. Additionally, we omit the dual for reasons of space, but generalization extends to that number, as well.

[4]This data from Ryding (2005) and Benmamoun (1997).

"He wrote ⟶ he did not write" (Moroccan)

c. bətlaʕ ⟶ ma-bətlaʕ
go.out.1S ⟶ NEG-go.out.1S
"I go out ⟶ I don't go out." (Syrian)

Another place where the non-concatenative part of NM appears to be descriptively absent concerns words which have been argued to be derived from other words instead of a consonantal root (Bat-El, 1994; Ussishkin, 1999; Arad, 2005). The most commonly-cited case of this phenomenon concerns DENOMINAL VERBS which are putatively formed from the combination of an existing noun with further affixal material. In Hebrew, this phenomenon can even go so far as to carry along affixal material attached to the "base" noun before it is verbalized, as in (9).

(9) Denominal Verbs Contain Nominal Affixes in Hebrew:
   a. kamc**-an**, "stingy person" ⟶ hitkamce**n**, "was stingy"
   b. kic**-on-i**, "extreme" ⟶ hikci**n**, "brought to extremity"
   c. **ta-**xzuk**-a**, "a maintenance" ⟶ **t**ixzek, "maintained"
   d. **mi-**spar, "number" ⟶ **m**isper, "enumerated"

In each of the examples in (9), the bolded affixes arguably attach only to nouns, making their appearance in the corresponding verb inexplicable unless the verb is itself denominal (see also the discussion on consonant cluster transfer in §2.2). Moreover, as Arad (2005) points out, these denominal verbs often have relatively compositional semantics insofar as they have predictable meanings vis-à-vis their underlying nouns and do not have access to more idiosyncratic meanings of the same roots in other contexts. In §3.4 we mention briefly how a similar phenomenon can be observed in the nominal domain. What these facts amount to is the need to understand not only the NM portions of these languages, but also the "point of no return" to non-concatenativity — there must be a theoretical explanation for the conditions under which NM can and cannot arise in a given language.

As we have seen in this section, the classical descriptive picture that emerges in Semitic is one of (i) non-concatenativity in certain places related to templatic alternations which track verbal argument structure loosely and (ii) concatenativity in places related to inflection, negation, and cases in which morphology appears to be deriving words from other words. In the following section, we turn to outlining how these phenomena were treated in pre-DM accounts.

2.2 Pre-DM Approaches

Prior to the advent of DM, approaches to NM largely took as theoretical *desiderata* the empirical generalizations concerning NM from Semitic described in §2.1 and attempted to locate an explanation in phonological terms with minimal reference to syntactic structure. In this section, we briefly review two classes of pre-DM accounts: "phonology only" accounts which derive NM effects using phonological frameworks alone (§2.2.1) and "augmented phonology-only" accounts which appeal to phonological frameworks as well as a notion of word-based derivation or output-output effects (§2.2.2).

2.2.1 Phonology-Only Accounts

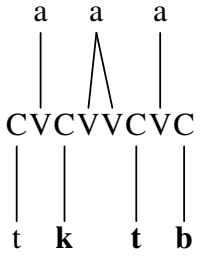
The first treatment of NM effects as a theoretical entity appears in the dissertation and related work of McCarthy (1979; 1981; 1985), who developed a theoretical treatment of Arabic and

Hebrew NM via an extension to Autosegmental Phonology (Goldsmith, 1976). In this account, NM morphology comes about because of the distinct nature of morphemes in NM languages, which are assumed to be morphemes that associate phonological material with distinct portions of autosegmental tiers.

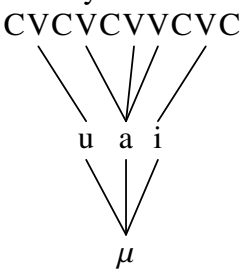
Concretely, accounts following McCarthy (1979) assume that NM languages have at least three theoretical objects associated with any representation: (1) the root, a collection of 2-4 consonants assumed to be the locus of lexical/conceptual meaning; (2) the CV-Skeleton, a template of consonants and vowels assumed to be the locus of voice/argument structural meaning; and (3) the vocalic pattern, a collection of vowels which are assumed to be the locus of tense/aspect meaning. The root (1), vowels (3) and any affixal material associate to the skeleton (2) via the normal mechanisms of Autosegmental Phonology using left-to-right association followed by conflation of the autosegmental tiers into a single phonological representation.

Two sample representations in this system appear in (10–11) for a verbal and nominal representation, respectively (McCarthy, 1981:392). In (10) the root consonants are shown in bold, and non-root consonantal affixal material is shown in regular face. The key postulate of this approach can be seen in the fact that the distinct portions of NM appear on distinct autosegmental tiers in these representations. In all cases, each tier constitutes a morpheme *sui generis*, a fact which is represented overtly in (11) by the symbol μ but is largely optionally reproduced in most diagrams.

(10) Arabic *takaatab* 'corresponded' default verbal vowel *-a-*:



(11) Arabic participle *mutakaatib* melody *u-a-i*:



While couched in a theoretical background that has a very distinct definition of the term "morpheme" from DM, the early accounts by McCarthy were groundbreaking insofar as they could account for the empirical generalizations concerning the appearance of consonantal roots across many distinct derived forms. The fact that roots and vowels seem to contribute differentially to derived word meaning despite being discontinuously interleaved falls out immediately from the general machinery of autosegmental phonology — a great result given the concatenative morphological theories available at the time. However, this approach runs into a explanatory adequacy issue concerning the CV-skeleton — while loosely related to the notion of argument structure, the CV-skeleton appears in this theory largely to stipulate the exact output order of root, affix, and vocalic elements.

Recognizing the singular nature of the CV-skeleton, McCarthy and Prince (1990) and McCarthy (1993) redevelop the insights from McCarthy's early work in the theory of Prosodic Morphology, a framework which was popular at the time. This account recasts the templatic effects as the result of a stipulation that templates be a well-formed prosodic unit, typically (among other shapes) a binary foot. Via interactions of such prosodic constraints, McCarthy (1993) shows that the explanatory burden borne by the CV-skeleton can be reduced to the normal constraints on word-level prosody in NM languages. As a result, the particular shape of templates can be analyzed as the maximally unmarked prosodic constituent possible given the inputs. While these early accounts simply stipulated the equivalency of templates and prosodic

units, this is not strictly required if prosodic shapes are taken to be forced by the constraint interaction logic of Optimality Theory (OT, henceforth; Prince and Smolensky, 1993/2004).

The Prosodic Morphology account provided several improvements relative to the early Autosegmental Phonology accounts. Firstly, it provided an explanatory basis for the specific shapes of templates (assuming the OT approach), dispensing with the CV-skeleton approach required in earlier works. Moreover, the constraint interaction logic inherent in Optimality Theory helped provide a better cross-linguistic typology of NM and non-NM languages — wheres the earlier work of McCarthy (1979) had to stipulate that NM languages had word formation processes governed by Autosegmental Phonology, the Prosodic Morphology account could appeal to standard Optimality-Theoretic factorial typologies to claim that what makes NM languages special is simply their highly-ranked prosodic markendess constraints and not a distinct morphological process *sui generis*. Later on, this account was also extended to account for NM interactions with concatenative affixation in McCarthy (2005).

In many ways, the various approaches pioneered by McCarthy laid the foundation for all subsequent work on NM in generative grammar. In addition to codifying the empirical generalizations requiring theoretical explanation, McCarthy's work showed quite convincingly that accounts of NM effects must relate the appearance of non-concatenativity to the particulars of the phonological systems of individual languages. The later work in Optimality Theory strengthened this point by showing that NM languages are often the same languages with stringent requirements on word-level prosody or the appearance of complex syllable margins, opening an avenue for explaining non-concatenativity via word-level prosodic or phonotactic restrictions needed independently for the phonological analysis of NM languages.

Returning to the central questions in (3), we can see that the early phonology-only accounts stake out clear positions on several of the key issues in NM. Firstly, morphological material can be realized discontinuously either because of the nature of autosegmental representation in general (pre-Prosodic Morphology) or the language-specific requirement that templates be equivalent to a prosodic unit (in Prosodic Morphology). NM languages are therefore typologically unique because their lexicons must contain consonantal roots and discontinuous vowel morphemes which are, by their very nature, abstract and never seen in isolation. Prior to the move towards Prosodic Morphology accounts, phonology-only approaches were less well equipped to explain the role of phonotactics and prosody in word-formation, but following that move, these effects fall out of the stipulation that templates be authentic units of prosody. However, these accounts are open to criticism from a theoretical parsimony perspective — there is no explanation as to *why* NM languages are the way they are. It is a stipulative accident that Semitic languages have NM and Germanic does not, and there is no explanation as to why we find so few languages with only a modest amount of NM.[5] Finally, by their nature as phonology-only accounts, the proposals in McCarthy (1979), *et seq.*, can say very little about the nature of compositionality and its relationship to NM in general.

2.2.2 Augmented Phonology-Only Accounts

Shortly after the development of the Prosodic Morphology account of NM, various researchers began to investigate places where the root-based approach originating in McCarthy (1979) was at odds with the empirical situation in Semitic. The most sustained line of attack comes from the work of Bat-El (1994; 2002; 2003; 2008; 2017) and Ussishkin (1999; 2000; 2005), with more

[5]The spirit of the Prosodic Morphology movement was arguably that *all* languages are subject to the constraint that word-level templates are governed by prosody, but such accounts — later formulated in OT — have been shown to over-generate by Embick (2010).

recent echoes in Laks (2013a;b; 2014). In these works, Bat-El and Ussishkin argue that limited corners of Semitic show evidence for words derived from other words, a representation not available in either McCarthy's early approaches or traditional OT. Since the early phonology-only accounts assumed all derivations began with a consonantal root, the argument goes, then evidence for complex words whose base is not the root constitutes *prima facie* evidence against completely root-based accounts.

To take an example, Bat-El (1994) argues that denominal verbs in Hebrew require derivations in which verbs are created from nouns (see also (9), above). The crucial empirical argument comes from a phenomenon known as CLUSTER TRANSFER, whereby denominal verbs preserve consonant clusters present in the underlying noun but which are not predicted by a root-and-template approach like that in McCarthy (1981). Examples of denominal verbs from Bat-El (1994) appear in (12):

(12) Cluster Transfer in Modern Hebrew Denominal Verbs:
   a. **pr**a**kl**it, "lawyer" ⟶ **pr**i**kl**et, "practiced law" (*pirklet)
   b. gu**ʃp**a**nk**a, "approval/seal" ⟶ gi**ʃp**e**nk**, "approved/sealed" (*giʃnek)
   c. **tr**a**nsf**er "transfer" ⟶ **tr**i**nsf**er, "transferred" (*tirnsfer)

The word pairs in (12) each contain one or more consonant clusters (shown in bold) in a verb which are unexpected from the perspective of root-and-pattern association because the clusters do not match the syllabification that would be expected on templatic approaches (the starred forms in parentheses). Instead, the clusters are only explicable, according to Bat-El (1994), if the related noun is taken into account — the clusters seen in the denominal verbs are the same clusters found in the noun. Bat-El (1994) suggests a denominal derivation for these verbs, one which is not tractable in theories which take all NM languages to involve word formation that associates discontinuous roots with prosodic templates. Stepping back from the particulars of Hebrew denominal verbs, the crucial argument is that some word-formation processes in NM languages need to be analyzed in terms which allow word-like inputs to subsequent word formation.

Picking up on the idea that word-based derivations may be required in NM languages despite NM effects being widespread, Ussishkin (1999; 2000; 2005) develops a radical approach wherein NM effects are derived via Output-Output Correspondence (Benua, 2000) in Optimality Theory. In this approach, which he dubs the FIXED PROSODY approach, NM effects in the verbal domain arise from an interaction of phonotactic and prosodic markedness constraints with output-output faithfulness constraints that require output forms to be maximally similar to a base — for denominal verbs, this base can then be the corresponding noun. Ussishkin (2000; 2005) argues that the entire verbal NM paradigm in Semitic can be derived using the same approach, and that a reasonable base is the *XaYaZ* form. This is a sensible postulate language-internally, since this form has the most unmarked prosodic shape (a binary foot with no consonant clusters) and arguably the most unmarked semantics.

Beyond simply allowing the derivation of denominal verbs via output-output correspondence, the approach in Ussishkin (2000; 2005) allows an even more radical departure from previous work in that the consonantal root is no longer required as an input to NM derivations. Ussishkin shows that as long there is output-output faithfulness to the *XaYaZ* form, all that is required as inputs to other NM patterns in Semitic is the vowels and affixal material present in the derived form. Output-output correspondence constraints ensure that root consonants are preserved in the output and prosodic markedness constraints ensure that they appear in the correct prosodic positions. On parsimony grounds, Ussishkin suggests that analyses of NM should not posit a discontinuous consonantal root which is never visible in isolation.

Ussishkin's work generated a great deal of interest largely because of its radical proposal concerning the phonological status of the root in Semitic. On a basic heuristic level, the root in Semitic appears a strange object — by definition, it can never be seen contiguously or alone, and with the exception of small pockets in other language families (see §4), the descriptive phenomenon is limited to one language family. For many, a theory which does not require recourse to a typologically unique item is preferable to one which does. The Fixed Prosody accounts also inherit many of the answers to our Central Questions in (3) that come from phonology-only accounts, but possibly improves upon the typological idiosyncrasy of NM: Semitic is not special because it has a typologically rare lexicon full of consonantal roots, but rather special because of its highly-ranked prosodic and phonotactic constraints. This improvement also allows Fixed Prosodic accounts to explain why NM is often either entirely present or entirely absent in languages — the constraint ranking in OT is assumed to be language-wide by default, and so a language which prizes prosodic and phonotactic constraints over morpheme integrity will see NM throughout its morphological system.

However, one of the major challenges faced by the Fixed Prosody theory of NM is the lack of available bases for output-output correspondence (Marantz, 1997; Doron, 2003; Kramer, 2006; Kastner, 2018). Many "derived" verbs in both Hebrew and Arabic lack an attested *XaYaZ* form, meaning that the Fixed Prosody account is required to posit output correspondence to a form that never appears in any output. Moreover, the reliance on a single base word as input to *all* subsequent derivations struggles with idiosyncratic meaning in "derived" patterns. To the extent that one can find, e.g., *iXtaYaZ* forms that do not have a meaning compositionally derived from the *XaYaZ* form, Fixed Prosodic accounts will need to say more, and the result is a nebulous answer to question (3e) about the relationship between form and meaning in NM. This argument is especially troubling when one observes that wug-testing in NM languages can yield patterns consistent with decompositional approaches to complex words in NM languages (Twist, 2006; Ussishkin and Twist, 2009; Moore-Cantwell, 2013; Temkin Martínez, 2013; Temkin Martínez and Müllner, 2016; Ahyad and Becker, To appear).

Moreover, the Fixed Prosody account also needs added stipulations to account for so-called WEAK VERBS, verbs where a glide appears in one of the root consonant positions. As pointed out by Tucker (2011a;c), when these verbs appear in the *iXtaYaZ* form in Arabic, a geminate /tt/ infix appears instead of the usual /t/:

(13) Weak Roots in *iXtaYaZ* in Iraqi Arabic:
   a. ittiʤah, "to head (for)" ($\sqrt{\text{wʤh}}$; *utiʤah, *wtiʤah)
   b. ittiqan, "to master, know well" ($\sqrt{\text{jqn}}$, *itiqan, *jtiqan)
   c. ittixað, "to take, adopt" ($\sqrt{\text{ʔxð}}$, *ʔtixað)

In all the *iXtaYaZ* forms in (13), the glide does not appear in the surface form of the verb, but a geminate /tt/ appears instead despite the normally singleton infixal /t/ being expected. The empirical generalization here was known to the ancient Arab grammarians: the /t/ geminates because of the loss of the glide. While the Fixed Prosody account could in principle relate the gemination to an input-output relation constructed over the glide, what cannot be motivated is the loss of the glide in favor of a geminate, as this process is not found elsewhere in the phonology of Arabic.

Stepping back from particular accounts, one can see that the the pre-DM approaches share a common strand which has remained at the center of generative approaches to NM, whether situated inside DM or not. This strand takes the templatic nature of verbal derivation to be fundamentally about phonological structure and suggests that what is unique about NM languages

is a set of phonological differences which require adherence to a rigid phonological structure. As we shall see in the next section, this postulate remains at the forefront of many DM-inspired approaches.

3 DM approaches to NM in Semitic

In this section we review the major approaches to NM in Distributed Morphology and attempt to sketch the Current Consensus as outlined in (4). Work on Semitic within DM has, without fail, associated the DM root with the traditional Semitic root, taking its cue from proposals by Marantz (1997) and Arad (2005). Assuming that the Semitic root can be formalized as the DM root, two questions arise: what kind of information is encapsulated in the root, and what kind of grammatical primitives give rise to the templates? The question of roots has been addressed to some extent with respect to the phonology, while the status of the semantics of roots has proven more difficult to pin down. The question of templates has seen a convergence on the notion that Voice heads regulate argument structure and that in Semitic these heads have overt exponents which either feed into templatic morphophonology or are the templates themselves.

The appeal of using DM to approach these questions is immediate: one structural element, the root, maps fairly deterministically onto both the syntax-semantics and the phonology. Another structural element, the template, likewise maps onto both interfaces, assuming the phonological content or processes that give rise to templates are isomorphic to some set of meanings. A theory of morphology such as DM, in which the syntax feeds both interfaces, allows us to model these relationships in a relatively straightforward way: the syntax assembles, and the interfaces interpret, with NM appearing as an emergent property of mapping syntax onto its interfaces.

Because such a modular and interactional approach to NM is difficult to sketch coherently all at once, we organize our discussion in this section around three major descriptive pieces of NM if the Current Consensus is correct: roots (§3.1), templates and/or templatic effects (§3.2), and the phonology that intertwines them (§3.3).

3.1 Roots

Given that DM has encoded Semitic roots as morphological roots since the earliest work combining the two (Marantz, 1997; Arad, 2003), a natural approach to understanding the idiosyncrasy of Semitic roots has been to characterize the interpretation of morphological roots within the syntactic structure. But NM provides a few additional challenges which we outline here.

DM enables researchers to discuss the templatic morphology of Semitic languages using the same tools which have proven insightful for other languages. However, while it is relatively easy to specify the range of argument structure alternations associated with a given template (or affix), it is much harder to specify the range of meanings associated with a given root. Remaining within the verbal domain for argument's sake, recall that according to the traditional claim, words sharing a root share some basic meaning. In the Hebrew data in (14a–b), the form in *niXYaZ* is an anticausative variant of the transitive verb in *XaYaZ*, which is the base for the causative form in *hiXYiZ*. The same meaning of the root is used across all three forms, with only basic modifications to argument structure varying from template to template. Appealing as this potential generalization may be, it does not stand up to further scrutiny (Schwarzwald, 1973; Arad, 2005; Harley, 2014). Most roots take part in alternations in which the intuitive semantic cohesiveness is much more lax; in (14c), for example, the form *hisgir* does not mean

'caused someone or something to be closed', but the more semantically opaque 'extradited'. These kinds of alternations are often the norm in Semitic, rather than the exception.

(14) Idiosyncratic Root Meaning In Hebrew:

		niXYaZ		*XaYaZ*		*hiXYiZ*	
a.	$\sqrt{\text{ktb}}$	*nixtav*	'was written'	*katav*	'wrote'	*hextiv*	'dictated'
b.	$\sqrt{\text{krj}}$	*nikra*	'was read'	*kara*	'read'	*hekri*	'read out'
c.	$\sqrt{\text{sgr}}$	*nisgar*	'was closed'	*sagar*	'closed'	*hisgir*	'extradited'

The major works touching on the interpretation of Semitic roots within syntactic approaches to word-building include Doron (2003), Arad (2005), Borer (2013) and Kastner (2016). These authors all worried about how much semantics is shared between verbs of the same root, how much the meaning can vary, and what kind of generalizations should be captured by a formal theory. While a complete answer is still forthcoming from the literature, all of these works made great strides in understanding the meaning of Semitic roots with crucial use of the tools of DM.

Doron (2003) observes, focusing on the verbal system, that the strongest form of possible generalizations about root meanings arises only when a root is instantiated in more than one template. That is to say, if a root appears in two templates, the alternation is predictable. So while "one-off" verbs like *xadal* 'ceased', *higlid* 'healed (wound)' and *hitaxzer* 'behaved cruelly' have roots which only appear in one template, the choice of which may be arbitrary (here *XaYaZ*, *hiXYiZ* and *hitXaY̆eZ* respectively), *nixtav* 'was written' alternates predictably with *katav* 'wrote', as in (14a). This generalization appears to be correct, although the question remains of how it should be derived. And returning to the question of the range of meanings associated with a root, we cannot use this idea to explain how, for example, *hisgir* 'extradited' is so much farther away semantically from *sagar* 'closed' than *nisgar* 'was closed' is.

Arad (2005:77), as part of a general view embracing the idiosyncrasy in Semitic root meaning, puts forward the notion of MULTIPLE CONTEXTUALIZED MEANING, a way of talking about the phenomena whereby different meanings of the root are available in different grammatical contexts. For the nominal domain, for example, Arad suggests that each combination of root and pattern has its meaning listed in the Encyclopedia. For local morphosyntactic combinations of v and the root, these meanings may also be listed in the Encyclopedia, while more non-local combinations of categorizing heads (as in denominal verbs) can only augment meaning compositionally. However, the combinations of categorizing heads and roots are not necessarily predictable, rendering the predictive powers of the theory relatively weak, as we return to in Section 3.2.2.

Other theories have also been hard pressed to answer the question of meanings across roots convincingly. Borer (2013) largely sidesteps the question, since in that theory root meaning can only be looked up in the context of a specific syntactic structure (see also the chapter on the Exo-Skeletal Model). And while Kastner (2016) attempted to characterize the cases in which the meaning of a template can diverge from its general meaning (e.g. when verbs in niXYaZ are not anticausative but inchoative), he too was unable to provide a coherent way of thinking about root meaning.

Where does this leave us? Unfortunately, the issue of root meaning cannot easily build on proposals elsewhere in the non-NM literature. As the chapters on allosemy, interpretation of structures and interpretation of roots all showcase, the questions of what information is encoded in the Encyclopedia and to what extent this information is shared between the different instantiations of the root is a thorny one (Embick, 2012). What DM gives NM is a formally

robust way of talking about shared meaning in derived forms such as nominalizations and argument structure alternations (a topic we explore in the following section). What NM gives DM is an important sandbox for theories of root meaning, specifically because the morphology keeps the theory honest; in most cases it is fairly easy to see which form is derived from which when both share a root.

Perhaps one way of approaching this question is not through theoretical argumentation but by using computational modeling, of the kind measuring word similarities based on co-ocurrences in a corpus (see Lenci 2018 for one recent overview); recent work has attempted to characterize the degree of variance in a root's meaning by considering the contexts in which this root appears in a corpus (Kastner, in prep). But whether formally or computationally, much clearly remains to be done on the question of root meaning as one of the clearest outstanding problems in DM work on NM.

3.2 Templates

The second major domain of exploration concerns the shape which governs the interleaving of root consonants and vowels — the template. The Semitic templates are canonically associated with certain argument structure configurations. Take for example the Hebrew root $\sqrt{\text{ktb}}$, generally associated with writing-related events. Four variants of the verb 'wrote' appear in different templates in (15).

(15) Putative Argument-Structural Correlates of Template Shape:

	Template	Verb	Gloss	Note
a.	*XaYaZ*	katav	'wrote'	unmarked/transitive
b.	*niXYaZ*	nixtav	'was written'	anticausative of *XaYaZ* (15a)
c.	*hiXYiZ*	hixtiv	'dictated'	causative of *XaYaZ* (15a)
d.	huXYaZ	huxtav	'was dictated'	passive of *hiXYiZ* (15c)

One of the major contributions of DM work on Semitic is the recognition that the templates can be arranged along two descriptive axes, "voice" and "agency", as suggested initially by Doron (2003). For the Hebrew examples we started off with in (5), this would look as in (16), though other classifications are possible as well. The question is what syntactic primitives derive this typology of templates, or any other relationship between the templates which is systematic as in (15).

(16) An Argument-Structural Typology of Templates:

	Voice		
Agency	Simple Voice	Middle Voice	Passive Voice
Simple	*XaYaZ* gadal 'grew'	*niXYaZ* nirdam 'fell asleep'	— — —
Intensive	*XiY͡eZ* gidel 'raised'	*hitXaY͡eZ* hitkabel 'was received'	*XuY͡aZ* gudal 'was raised'
Causative	*hiXYiZ* higdil 'enlarged'	— — —	*huXYaZ* hugdal 'was enlarged'

When the data are laid out this way, it is tempting to think of an alternation such as that between *XaYaZ* and *niXYaZ*, (15a–b), as a causative-inchoative alternation. However, even though alternations of the kind seen in (15) are prevalent, we have seen in (§3.1) that the Semitic system gives rise to many idiosyncrasies. Another example is given in (17).

(17) Hebrew Templatic Non-Compositionality:

	Template	Verb	Gloss	Note
a.	*XaYaZ*	pakad	'ordered'	
b.	*niXYaZ*	nifkad	'was absent'	not an anticausative of *XaYaZ* (17a)
c.	*hiXYiZ*	hifkid	'deposited'	not a causative of *XaYaZ* (17a)
d.	*huXYaZ*	hufkad	'was deposited'	passive of *hiXYiZ* (17c)

It is not possible to claim that (17a–b) form an alternation, even though the morphological templates are once again *XaYaZ* and *niXYaZ*. This problem runs even deeper, since verbs exist in *niXYaZ* without any alternation sharing the same root in *XaYaZ*, such as *nirdam* 'fell asleep', where no verb **radam* exists. Only the behavior of passive templates is fully predictable (Reinhart and Siloni, 2005; Ussishkin, 2005; Alexiadou and Doron, 2012; Kastner and Zu, 2017), where in Hebrew this refers explicitly to the templates *XuY̱aZ* and *huXYaZ*. While we illustrate these facts for Hebrew, similar arguments can be made for Arabic.[6]

Since it is not practical to discuss every pair of alternations here, we will exemplify the different theories below using one three-way alternation between "simple" *XaYaZ*, "intensive" *XiY̱eZ* and "intensive middle" *hitXaY̱eZ* in Hebrew. The relevant data are as follows:

(18) a. ha-martsa **kav'**-a et moed ha-bxina
the-lecturer.F **set.SMPL**-F ACC date.of the-exam
'The lecturer set the exam date.'

b. eʃet roʃ ha-memʃala **kib'**-a et maamad-a ba-xevra
wife.of head.of the-government **set.INTNS**-F ACC standing-hers in.the-society
'The Prime Minister's wife cemented her place in society.'

c. maamad eʃet roʃ ha-memʃala **hitkabea** ba-xevra
standing.of wife.of head.of the-government **set.INTNS.MID** in.the-society
'The Prime Minister's wife status in society was established.'

Stepping back from the empirical particulars, morphosyntactic analyses of the templatic system need to account for the following points relating to the syntax and semantics of templates:

(19) a. Specific argument structure alternations hold between specific template pairs (e.g., the causative alternation in Hebrew *XaYaZ*~*niXYaZ*).

b. Some roots may flout these regularities, leading to idiosyncratic interpretation of a given root in a given template.

c. Nevertheless, templates are associated with certain syntactic configurations which cannot be violated regardless of the root (e.g. verbs in *niXYaZ* and *hitXaY̱eZ* are never transitive).

[6]The relevant Arabic templates include *XaYYaZ*, *XaaYaZ*, and a "vocalic passive" formed from *XaYaZ* by replacing the initial vowel with /u/.

We will now outline how the major analyses of Semitic templates within DM were set up, discussing to what extent they are successful in addressing these points. Once again, the discussion will focus on Hebrew for concreteness' sake, though we believe that the main arguments adduced here hold for Arabic, as well.

3.2.1 Distributed morphosemantics

One popular approach to Semitic templates is to encode the putative argument-structural alternations exemplified in (16) directly into syntactic heads with clear denotational meaning at the semantic interface. We call this approach DISTRIBUTED MORPHOSEMANTICS because of its utilization of DM's syntactic decompositions alongside morphemes with largely compositional semantics.

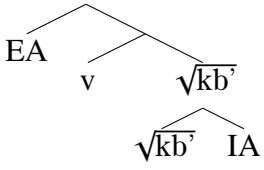
Doron's (2003; 2014) seminal treatment of Hebrew set out to derive her proposed distribution in (16) above by proposing two syntactic heads. The "agency" of a verb is entailed by two distinct heads, INTNS(ive) and CAUS(ative), whereas the status of the external argument is manipulated by two possible Voice heads, MID(dle) and PASS(ive). In this system little v introduces the external argument, and internal arguments are introduced by the root. Some heads attach to roots and some to verbs. The alternations in (15) are derived schematically as in (20), where "EA" and "IA" stand for external/internal argument.

(20) Doron's (2003; 2014) Distributed Morphosemantics:

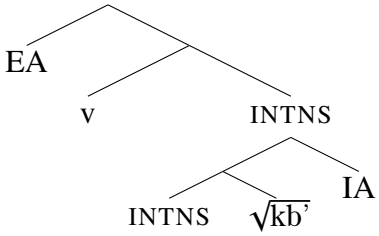
	Template	Verb	Gloss	Structure
a.	*XaYaZ*	katav	'wrote'	[EA v [IA $\sqrt{\text{ktb}}$]]
b.	*niXYaZ*	nixtav	'was written'	[IA [MID $\sqrt{\text{ktb}}$]]
c.	*hiXYiZ*	hixtiv	'dictated'	[EA [CAUS [IA $\sqrt{\text{ktb}}$]]]
d.	*huXYaZ*	huxtav	'was dictated'	[PASS [CAUS [IA $\sqrt{\text{ktb}}$]]]

Let us see how this system derives the three forms in (18). The root provides basic semantics and introduces the internal argument. Little v introduces the external argument and the Agent role (similar to what Voice does in more recent frameworks). This combination gives us (21a). The head INTNS modifies the event, adding an Agent role if there was none yet. It also spells out *XiY̲eZ*, as in (21b). The alternation, as it were, "happens" very low, at the level of root-attachment. Adding the non-active head MID instead of v removes the requirement for an Agent, and spells out *hitXaY̲eZ* together with the INTNS head, (21c).

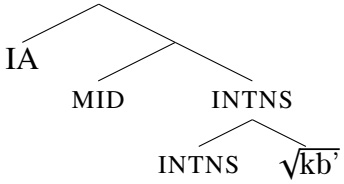
(21) a. *kava* 'set':



b. *kibea* 'cemented':



c. *hitkabea* 'was cemented':



It should be noted that other uses of these templates necessarily lead to slightly different derivations. For example, unaccusative verbs in *XaYaZ* or unergative verbs in *hitXaYeZ* will look differently. However, this example illustrates well the basic architecture.[7]

How does this system derive the analytical desiderata in (19)? Alternations hold fairly straightforwardly as a result of merging additional functional heads which manipulate the status of the external argument (cf. the chapter on argument structure). The idiosyncratic requirements of the root are accounted for by allowing it to take an internal argument; ostensibly the root then licenses only specific functional heads with which it is compatible in its superordinate structure. Since a head such as MID is stipulated to only combine with a root that did not take an internal argument, the non-transitivity of verbs with this head is also derived.

Certain aspects of this analysis have been critiqued on empirical grounds: Arad (2005) points out additional issues relating to idiosyncrasy, Kastner (2017) points out issues with deriving reflexive verbs and Kastner (2019a) critiques the analysis of inchoatives. Putting specific empirical puzzles aside, however, the question arises as to what the status of these proposed heads is. While Doron (2014) in particular attempts to recast the analysis in crosslinguistically familiar terms using Voice, there has been little attempt to investigate what these syntactic elements are like cross-linguistically. As such, they can be argued to be morphosemantic in nature, rather than morphosyntactic, although they clearly commit to a decompositional view of morphology.

Importantly in this regard, this influential contribution did not extend to a theory of morphophonology, something DM should be particularly good at. For instance, how exactly are the heads spelled out as templates? More pressingly, there are "discontinuous" cases such as [CAUS y x Root], where it is unclear how CAUS and Root combine to form one phonological word (perhaps via head movement, but this possibility is not raised). Given that the morphosemantics are only one-half of the empirical puzzle of NM, a Distributed Morphosemantic approach would need to come equipped with a morphophonological theory which explained how these functional heads come to receive their exponence.

Summing up briefly, Doron's work both brought intricate empirical patterns into a common formal framework and supplied specialists with new technical tools, couched in a system designed specifically to highlight important generalizations. At the time this theory was proposed, no work had attempted to impose such clear regularity on the semantics of Semitic templates, which had up until then been only descriptively summarized. While its adherence to regularity and compositionality is its eventual weakness, this theory is generally considered the one which any new theory attempts to measure up to.

3.2.2 Distributed conjugation classes

Arad (2005) took a different tack, attempting to scale back some of the structural commitments

[7] The theory also includes a causative head CAUS, which can take either a vP or a root (with potential internal argument) as its complement. This spells out *hiXYiZ*. But causative semantics can arise either from this head or from lower in the structure, i.e. the root itself. The head PASS attaches above all other heads, spelling out the passive templates.

about alternations which underlie work such as Doron's and, in a sense, embrace the messiness of Semitic templates. Her goal can be seen as the mirror image of the morphosemantic approach in that it attempts to leave as much of the idiosyncrasy unexplained as possible, while still allowing room for regularities. Because the ultimate picture that emerges treats templates much like morphosyntactic conjugation classes in more familiar Romance languages, we call this approach DISTRIBUTED CONJUGATION CLASSES. This theory has a number of components.

Syntactically, a standard DM-inspired VP-shell structure is built up including a root, v and Voice. The verbalizer v additionally has four semantic "flavors" (cf. Folli and Harley 2006 and the chapters on argument structure, allosemy and interpretation of structure). These heads are then said to combine syntactically in the usual way and both the semantics and phonology are allowed to interpret large parts of this structure idiomatically.

The template does not spell out a single node but is divided into a prosodic skeleton (CV-template) on v and vowels on Voice. The motivation for this split is that the vowels depend on the template: from the existence of *XiY̲eZ* it follows that the vowel combination -i,e- only goes with CVCCVC, whereas from the existence of *niXYaZ* it follows that -i,a- only goes with nVCCVC. Other vowel combinations, such as -a,e-, can spell out a number of Voice heads (cf. future *je-v**a**ʃ**e**l* 'will cook' and future tense *jit-b**a**ʃ**e**l* 'will get cooked'). Modern Standard Arabic, moreover, has a passive form of *XaYaZ*, *XuYaZ*, a fully ablauting passive not available to other "base" templates.

In order to fit these morphosyntactic pieces together and derive the correct predictions, a number of additional theoretical tools are required. First, roots select the templates they appear in, as a given root may idiosyncratically appear only with certain templates. Second, there are four syntactic flavors of v: unmarked, stative, inchoative and causative, in order to account for the argument structural correlates of templatic form. Finally, in order to specify which templates alternates with which, Arad stipulates conjugation classes. For example, in Conjugation Class 4, *XiY̲eZ* is the causative variant and *hitXaY̲eZ* is the inchoative variant (Arad, 2005:220). It is assumed that the anticausative alternation goes from inchoative to causative.

What this system then does is specify spell-out rules using two sets of diacritics: which template a given flavor of v spells out, and which conjugation class this variant participates in.[8] Some of the spell-out rules are reproduced next, with the ones relevant to the examples in (18) highlighted (Arad, 2005:230–231). Rules for individual templates are given first in each block, followed by rules for conjugation classes.

(22) Distributed Conjugation Diacritics in Arad (2005):

a. $v_{unmarked}$:
   $\alpha \rightarrow$ ***XaYaZ***
   $\beta \rightarrow$ *niXYaZ*
   $\gamma \rightarrow$ *XiY̲eZ*
   $\delta \rightarrow$ *hiXYiZ*
   $\epsilon \rightarrow$ *hitXaY̲eZ*

b. v_{inch}:
   $\alpha \rightarrow$ *XaYaZ*
   ...
   $\epsilon \rightarrow$ ***hitXaY̲eZ***
   ...
   Conjugation 4 → ***hitXaY̲eZ***
   ...

c. v_{stat}:
   $\alpha \rightarrow$ *XaYaZ*
   Class 3 → *XaYaZ*
   Class 5 → *XaYaZ*

d. v_{caus}:
   $\gamma \rightarrow$ ***XiY̲eZ***
   $\epsilon \rightarrow$ *hiXYiZ*
   Conjugation 1 → *XaYaZ*
   ...
   Conjugation 4 → ***XiY̲eZ***
   ...

[8] Arad (2005:227ff41) claims that the diacritics are notationally equivalent to rules in the Encyclopedia, allowing them to interpret large segments of syntactic structure.

We get *kava* 'set' by applying the relevant rule from (22a), which essentially allows a root to appear in *XaYaZ*. The alternation between *XaYaZ* and *XiY͡eZ* is not considered grammatical enough to be formalized in this theory, so we move to the alternation between *kibea* 'cemented' and *hitkabea* 'was cemented' next. This is an alternation in which the former is causative and the latter anticausative, and so we find the causative template in (22d) and the anticausative ("inchoative") template in (22b). Finally, we match the two up in Conjugation Class 4. Using the correct flavors of v and the correct conjugation class ensures that only attested interpretations of the templates arise. There are no stative verbs in *XiY͡eZ* or *hitXaY͡eZ*, for example, because stative v only has rules that insert *XaYaZ*.

Since the goal of this work is to reduce the amount of generality encoded by the system, thereby allowing more room for idiosyncrasy which must be coded by root, the technical outcome is appropriate. The commitments and predictions regarding relationships between verbs across templates emerge as calcified tendencies, rather than grammatical principles. This does mean, however, that the theory ends up with functional structure which does not determine argument structure but is simply correlated with it. In addition, most of the syntactic work is carried out by the flavors of v, but these have no unique spell-out, begging the question of whether there is any independent motivation for them beyond accounting for the conjugation classes themselves.

Arad's theory therefore lets us see what a minimally restrictive but maximally faithful theory of Semitic morphology might look like: all alternations are stated, giving way to the idiosyncrasies of the root. This kind of view can also be seen in works such as Faust (2012), where templates are treated as individual morphemes with no reference to argument structure. As such, these approaches form a counterpoint to the more restrictive Distributed Morphosemantic approach, since they deny the syntactic heads responsible for templatic effects a unique argument-structural interpretation.

One final contribution of Arad (2003; 2005) is the important distinction between what is now commonly called root-derived and word-derived verbs. In Arad's (2005) account, the unconstrained idiosyncrasy in Hebrew disappears once a cyclic head is merged into the structure, meaning that the system by definition allows for both non-concatenative irregularity and concatenative regularity, a distinction which maps nicely onto the notion of "root-" and "word-"derived words. The work of Arad (2003; 2005) was therefore the first to show that DM was not challenged by the appearance of denominal verbs or other output-output correspondence effects, provided that the syntax could reasonably be assumed to contain a cyclic head marking the point of no return to non-concatenativity/irregularity.

3.2.3 Distributed prosody

In the period immediately following the publication of Arad (2003; 2005), the landscape in the DM literature on Semitic templates contained two strands of thought (the distributed morphosemantics and distributed conjugation classes accounts) which placed a premium on analyzing Semitic templates in terms of combinations of syntactic heads, either regularly or idiosyncratically. However, neither of these accounts contained a particularly elegant account of the phonology of these templates themselves — the dominant view at the time was largely Fixed Prosody-inspired accounts following Ussishkin (2000; 2005) or readjustment rules, and this view did not fit well with the syntactic approaches then being developed. It is therefore unsurprising that one approach that emerged during this time was an attempt to have one's cake and eat it too: an account that take roots situated in DM-style morphosyntax to be key components in word formation and derive template effects via reference to Optimality-Theoretic

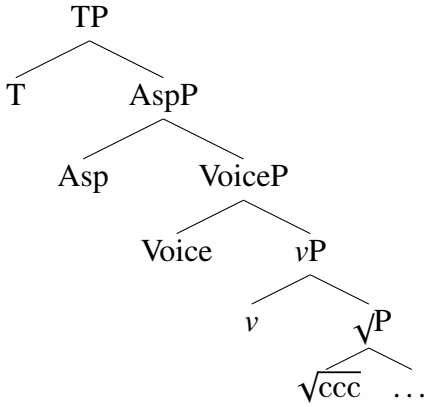
phonology that does not eschew a role for the root. The best examples of this line of inquiry are from the works of Kramer (2006; 2007) and Tucker (2011b). We call these accounts DISTRIBUTED PROSODY approaches, since they combine the analytical tools of DM syntax with heavy reference to prosodic considerations in deriving templates.

The first account in this line of research was purely phonological in nature and appears in the work of Kramer (2006; 2007), who analyzes NM in Coptic by developing an Optimality-Theoretic account of templates in terms of markedness constraints on prosodic word formation. Like Ussishkin (2000; 2005) before her, Kramer argues that templates do not need to appear as theoretical objects *sui generis*, but instead can be forced by a combination of highly-ranked constraints forcing feet to be binary and right-aligned to the prosodic word. Combined with restrictions on consonant clusters, these constraints (when undominated or highly-ranked) force the canonical CVCV(C) shape associated with Semitic and Afroasiatic NM. What separates Kramer's (2006; 2007) work from Ussishkin's, however, is a dependence on a representation that includes the consonantal root. Instead of Output-Output Correspondence to whole words, Kramer takes the consonantal root and related affixal material to be the input to the phonological derivation.

Tucker (2011a;c) extends these notions in a detailed Optimality-Theoretic account of the verbal NM system in Iraqi Arabic which he dubs the ROOT AND PROSODY APPROACH. Like Kramer, Tucker takes template morphology to arise from a specific interaction of prosodic and phonological markedness constraints which force a discontinuous root to surface interleaved with discontinuous vowel input. What makes this account particularly important for our discussion of Semitic template morphosyntax is that Tucker (2011b) then shows how this phonological account of template effects can be situated in a functional syntactic structure which is mostly isomorphic to DM accounts of Voice, meaning that the morphophonology of templates can be derived using minimal syntactic assumptions.

The structure assumed by Tucker (2011b) takes from Doron and Arad the idea that Voice plays a crucial role in the Semitic template, but is also designed to allow for periphrastic tense/aspect combinations involving the copular verb /kaan/ in Arabic via the inclusion of an Asp(ect) projection above Voice (see Bjorkman's chapter and the blocking chapter for similar ideas in other empirical domains). Specifically, Tucker assumes that the Arabic verb is an expression of at least three functional heads, as in the structure in (23):

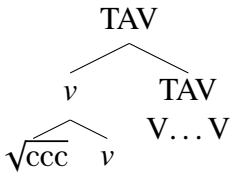
(23) Syntactic Structure Assumed in Tucker (2011b):



In this account, the consonantal root has phonological content and this head undergoes head raising successive-cyclically all the way to T (or Asp if the verbal auxiliary is present). Postsyntactically, T, Asp, and Voice are combined into one head via an instance of postsyntactic Fusion (Embick and Noyer, 2001) in order to account for the allomorphic dependency of vow-

els on both agreement (situated in T) and the root. The vowel melody is then assumed to be the exponent of this complex tense-aspect-voice (TAV) head, as in (24):

(24) TAV + Verb Complex Tucker (2011b):



After Fusion, the question becomes how this complex head is to be linearized, ensuring a non-concatenative output. Tucker (2011b) proposes to allow insights from the Iraqi studies to govern this linearization, reducing the template to a prosodic and phonotactic epiphenomenon. Tucker suggests that the terminal nodes in (24) — Prosodic Subwords following Embick and Noyer (2001) — are linearized by an Optimality-Theoretic grammar which forces non-contiguous output (see §3.3 for more discussion). The result is a derivation in which syntax assembles the complex head in (24) and inserts phonological exponents (the root and vowels), but prosodic phonology is responsible for linearizing this material discontinuously.

To recap, the template in Tucker's (2011b) account is epiphenomenal of the prosodic output given by the Optimality-Theoretical phonological component and does not appear as a dedicated piece of phonological exponence (following Ussishkin 2000; 2005). As a result, templates themselves do not have dedicated meaning, obviating the concerns about idiosyncrasy raised by Arad. Templatic effects arise because patterns other than *XaYaZ* contain additional phonological affixal material which forces alternative linearizations with various discontinuous effects on vowels given by the particular constraint ranking (Tucker, 2011a;c). These effects come about because of local interactions between the root, *v*, and Voice, though these interactions are not couched in cyclic terms. While neither Kramer (2006; 2007) nor Tucker (2011b) spell out the details of argument structure, their proposals make minimal enough assumptions about the syntax of Semitic verbs that their account of templates can largely be fitted onto any syntactic account. Tucker and Kramer's work is therefore an important transitional piece between the prior "phonology-only" accounts which stipulated templatic effects or derived them without countenancing the importance of roots and subsequent, "fully distributed" accounts which stress the importance of cyclicity in deriving the allomorphic effects seen in NM.

3.2.4 Distributed morphosyntax

The most recent wave of work on Semitic within DM (and on NM in general, as we shall see in §4) shifts the discussion towards theories in which functional heads are understood to be carrying out the exact same work in NM as in other languages. On this view, two factors conspire to give the impression of templatic morphology. The first is the morphophonology of these heads, whose behavior might be different than in concatenative languages. The second is the interaction of roots with these heads, leading to patterns of derivation which appear to be unique to a language or language family. Where theories have begun to converge is in the realization that these two factors single out domains where some of DM's most prominent analytical strengths lie (see the chapters on allomorphy, argument structure and root meaning). Accordingly, it makes sense to apply DM's standard tools to NM. We call this approach the DISTRIBUTED MORPHOSYNTAX approach, since it places most of the explanatory burden on the modular interactions between generally language-agnostic grammatical components in the truest spirit of Distributed Morphology.

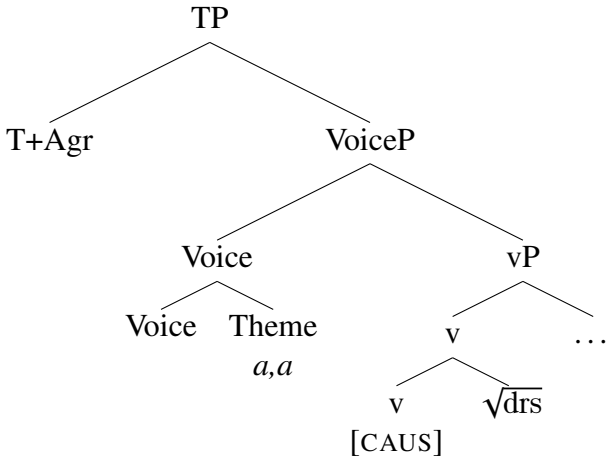
Works contributing to this recent development are naturally limited in scope, normally limiting their inquiry to one part of the equation. That is to say, they either make the case for certain functional heads deriving argument structure alternations in the form of templates, or they assume certain functional heads and derive the morphophonological properties of the templates. Nevertheless, some works do claim to provide a unified view of NM in a given language. What all these accounts have in common is an improvement over the Distributed Prosody accounts in terms of exact specifications of functional head interactions which attempt to situate themselves between the extremes of the Distributed Morphosemantics and Distributed Conjugation Classes approaches.

Perhaps the first substantial study along these lines was that of Alexiadou and Doron (2012), who contrasted non-active verbs in English, Greek and Hebrew. These authors used a uniform inventory of heads—active Voice, non-active Voice, and Passive—and showed how each language makes use of a subset of these heads. English has active Voice and Pass; Greek has active and non-active Voice; and Hebrew has all three. This analysis abstracts away from the phonological differences to explain quite elegantly how different affixes (or templates) track functional heads, which in turn induce specific argument structure alternations, in the three unrelated languages. This paper remains one of the clearest discussions of what it means for a verb or a construction to be "passive", elucidating the difference between what a Pass(ive) head entails and what a non-active Voice head might entail. This point was reiterated by Kastner and Zu (2017) in their analysis of the Hebrew passive which was mostly in step with Alexiadou and Doron (2012).

Wallace (2013), in unpublished work, was the first to propose a unified treatment of NM, linking functional heads with specific phonological implementation in Optimality Theory. In her study of Akkadian, Emirati Arabic and Iraqi Arabic, Wallace shifted the discussion by assuming that v and Voice heads have Vocabulary Items which are organized in the phonology according to prosodic constraints, synthesizing the major insights of all previous approaches. On the syntactic side, Wallace (2013) translated the morphosemantic heads from Doron (2003) into "flavors" of v and Voice. On the morphophonological side, she listed how each head is spelled out. And on the phonological-prosodic side, she identified the violable constraints which arrange these VIs into what appear like templates (extending the work by Tucker mentioned above). For example, the template *XaYYaZ* in Modern Standard Arabic is often a causative variant of *XaYaZ* (25). Wallace proposes the structure in (26) and the phonological constraint in (27) which places gemination at the right place in the verb.

(25) *daras* 'he studied' ~ *darras* 'he taught'

(26)



(27) ALIGN(R-μ_{caus}, L–σ]$_{Pwd}$):

> Align the realization of the causative morpheme to the left of the final syllable of the prosodic word. (Wallace, 2013:10)

Wallace's unpublished manuscript additionally made several remarkable predictions regarding contextual allomorphy which were only possible once DM-style assumptions and structure were in place. Wallace observes that vowel patterns in three Semitic template systems (Akkadian, Iraqi Arabic, and Gulf Arabic) are analyzable as allomorphy under linear adjacency (Embick, 2010), once the structure in (26) is assumed.[9] As an example, Akkadian has four theme vowel patterns that vary along aspects, but in a manner determined by the root (28):

(28) Akkadian Theme Vowel Classes:

Class	Imperfective	Perfective	Perfective	Gloss
a-u	i-pparr**a**s	i-ptar**a**s	i-pr**u**s	"to divide, separate out"
a	i-sˀabb**a**t	i-sˀsˀabb**a**t	i-sˀb**a**t	"to seize, capture"
i	i-ʃarr**i**q	i-ʃtar**i**q	i-ʃr**i**q	"to steal"
u	i-maqq**u**t	i-mtaq**u**t	i-mq**u**t	"to fall, collapse"

In the passive, these theme vowel classes reduce from four to two, suggesting an allomorphic interaction between Voice, Aspect, and the root (29):

(29) Akkadian Theme Vowel Classes in the Passive:

Class	Imperfective	Perfective	Perfective
a-u, a, u	i-pparr**a**s	i-ttapr**a**s	i-ppar**i**s
i	i-ʃʃarr**i**q	i-ttaʃr**i**q	i-ʃʃar**i**q

This allomorphic interaction can be captured straightforwardly under a DM-style linear adjacency theory of allomorphy, but only if v is assumed to be null, allowing Aspect, Voice, and the root to be adjacent. A major contribution of Wallace (2013) is to note the confirmation of a prediction of this approach: when v contains overt material, this root-sensitivity of the theme vowels should disappear, with theme vowels varying according to aspect only. This is what is found in the Akkadian intensive and causative, as in (30):

(30) Akkadian Theme Vowel Classes in Causatives & Intensives:

Class	Imperfective	Perfective	Perfective	Gloss
all	u-parr**a**s	u-ptarr**i**s	u-parr**i**s	Intensive
all	u-ʃa-pr**a**s	u-ʃ-tapr**i**s	u-ʃa-pr**i**s	Causative

While shown above only for $\sqrt{\text{prs}}$, the facts are identical for all verb classes, and very similar patterns exist in Iraqi Arabic and Gulf Arabic. What the lack of alternation in (30) shows is that overt material in v blocks allomorphic interactions between Aspect/Voice and the root, exactly as expected under a DM-style account of allomorphy under adjacency.

This analysis was, in our opinion, the first of its kind to relate the sometimes idiosyncratic nature of Semitic vowels to local interactions of known syntactic objects, and is therefore foundational to much of the modern DM approach to templates and their associated vowels. The

[9] It now seems that linear adjacency is too strict a theory of contextual allomorphy; see the chapter on allomorphy or Kastner and Moskal (2018) for discussion and references. Nevertheless, the main point about understanding NM in terms of concatenative locality holds regardless of what exactly that theory of locality will end up looking like.

crucial observation is that the idiosyncrasy of vowel selection is a root-governed phenomenon mediated by the normal constraints on allomorphy in DM. Combined with the OT-style account of syllabic shape, Wallace's theory outlines quite clearly how templates can be derived given an interaction of normal DM-style syntax with a properly specified OT-style phonology.

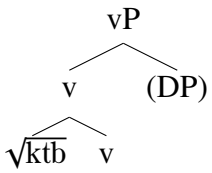
With this understanding of the templates now available, Kastner (2016; 2017; 2018; 2019a) began to examine the morphological system of a particular language in depth, in this case Modern Hebrew. His work dispensed with the notion of flavors of v (required by both Arad, 2005 and Tucker, 2011b), deriving alternations through use of a feature [±D] on Voice (Schäfer 2008; 2017; Wood 2015; Alexiadou et al. 2015, and see the chapter on argument structure) and an additional agentive modifier. Case studies of argument structure alternations on the syntactic-semantic side (Kastner, 2016; 2017; 2019a; Kastner and Zu, 2017) alongside detailed phonological derivations (Kastner, 2018) combined to give a uniform view of NM using the syntactic and phonological primitives available to other languages as well.

Like Alexiadou et al. (2015), this Voice-based system assumes that the vP contains the basic event, comprised of the verbalizer, a root, and potentially internal arguments. The question for Kastner is what kind of Voice head is merged next. His [D] feature on Voice is an EPP fature, regulating the merger of a DP in Spec,VoiceP. The three possibilities are (Kastner, 2016; 2018):

(31) Trivalent Voice
   a. Voice: unspecified for [±D], does not place any requirements on Spec,VoiceP.
   b. Voice$_{[+D]}$: requires a DP in Spec,VoiceP (Kastner, 2019a).
   c. Voice$_{[-D]}$: prohibits a DP in Spec,VoiceP (Kastner, 2017).

For example, unmarked Voice is equally happy with a root like $\sqrt{\text{ktb}}$ which derives the active verb *katav* 'wrote' and with a root like $\sqrt{\text{nfl}}$ which derives the unaccusative verb *nafal* 'fell'.

With these assumptions, then, the basic vP for $\sqrt{\text{ktb}}$ 'wrote' can be as in (32). This structure is not yet pronounceable (all verbs require Voice by hypothesis), but it already has a basic meaning: that of writing (as an activity) or writing something (if an internal argument, represented by DP in this tree, is merged).

(32)


There are now three options. If one continues by merging Voice, an external argument is introduced, and the spell-out rules of Voice give *katav* 'wrote' (the phonological derivations are developed more in §3.3.2):

(33) Voice ↔ *a,a* / T[Past] ___

If one merges Voice$_{[-D]}$, no external argument can be introduced, and the spell-out rules of Voice$_{[-D]}$ give *nixtav* 'was written':

(34) Voice$_{[-D]}$ ↔ *ni-,a* / T[Past] ___

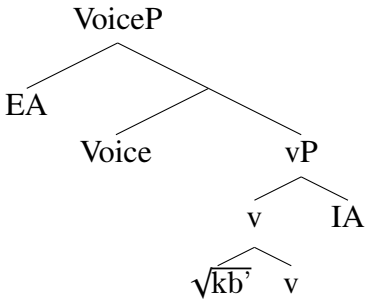
Finally, if one merges Voice$_{[+D]}$, an external argument is introduced, but since there is already the option of a transitive verb with Voice, this verb — *hixtiv* 'dictated'— will have to have different semantics (Kastner, 2019a).

(35) Voice$_{[+D]}$ ↔ *hi-,i* / T[Past] ___

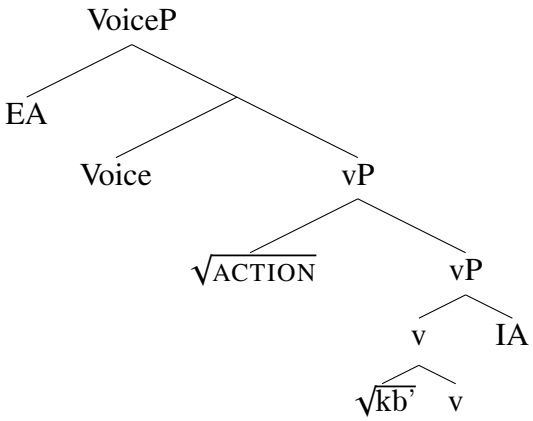
The work of Doron's "intensive" agentive head is, moreover, mimicked by the modifier $\sqrt{\text{ACTION}}$, which adjoins to vP and introduces additional agentive semantics. This modifier also gives rise to the two other templates of Hebrew, *XiY̲eZ* and *hitXaY̲eZ*, with their respective semantics and phonology (Kastner, 2017).[10]

The three-way alternation from (18) can now be exemplified. Merging Voice gives the simple transitive verb (36a). Attaching $\sqrt{\text{ACTION}}$ to the vP modifies its semantics, while still being close enough to the root to trigger further changes in meaning (36b). Merging $\text{Voice}_{[-D]}$ instead of Voice gives the anticausative alternation (36c). The core vP remains the same and the syntactic structures are rigid, in the sense that arguments merge in the same place each time (unlike in Distributed Morphosemantics); differences in meaning fall under the purview of the interpretative component and the root.

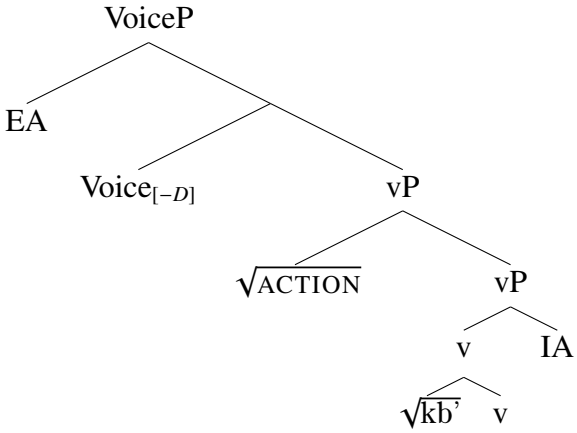
(36) a. *kava* 'set':



b. *kibea* 'cemented':



c. *hitkabea* 'was cemented':



[10]This modifier was originally proposed to attach to Voice (Kastner, 2016; 2017), likening it to similar elements in other languages. Yet Kastner (2019b) suggests it should merge lower, attaching to v rather than to Voice, in order to derive the alternation between *XiY̲eZ* and *hitXaY̲eZ* more transparently, following suggestions by Ahdout (2019; In prep). This is also the formalization we use here.

How is this system supposed to account for our analytical goals from (19)? Alternations hold between specific pairs because of the layering of Voice/Voice$_{[-D]}$/Voice$_{[+D]}$ atop vP. These alternations do not hold for every single root because some roots can impose their own restrictions on the structures they appear in. This is solved by relaxing the locality condition on selection of root meaning, the so-called Arad/Marantz Hypothesis (see the chapter on root meaning). Instead of assuming that the first categorizing head selects the meaning of the root (here v), Kastner (2016) assumes that Voice can choose a specific meaning of the root over v, if v itself does not choose such a meaning. And finally, templates do have certain syntactic restrictions regardless of the root because of the syntactic feature [D].

This syntactic analysis is then coupled with explicit morphophonological derivations (Kastner, 2018) — again building on Ussishkin (2005), Tucker (2011a) and Wallace (2013) — making Kastner's work the most complete exegesis of the Distributed Morphosyntax family of approaches. Yet as evidenced by the discussion above concerning the Arad/Marantz hypothesis, as well as the general points in §3.1 , it is not able to elegantly elucidate how the different aspects of root meaning correlate with, or select, different functional heads without additional stipulations.

However, we can step back from the particulars of root meaning to see how Kastner's work represents the most coherent exegesis of our Current Consensus in (4): NM templates are discontinuous because syntax does not require phonological continuity, but rather operates in terms of local combinations of functional heads. When a root appears in contexts that license particular argument structures one can find those meanings, but there is no explicit relationship between particular meanings and particular phonological forms except insofar as they are both interface interpretations of the same syntactic structure.

Summing up, work in Distributed Morphosyntax provides a clear picture of the Current Consensus and is built on the DM approaches that come before it. Importantly, it takes the root in NM to be synonymous with the root in DM, and derives templatic effects as epiphenomenal of the interaction of syntax and phonology. This is, we think, a laudable result, since it reduces the apparent complexity and idiosyncrasy of Semitic roots and templates to interactions between well-understood modules of the grammar in familiar ways. What still remains is to ensure that the phonological particulars are in order, which we do in the following section.

3.3 Phonology

One consequence of the focus on argument structure and valency alternations in the early DM work on NM is that accounting for the phonological (or morphophonological) patterns in a detailed fashion often fell by the wayside. The most recent waves of work have revisited this issue, where what we have in mind is the Distributed Prosody and Distributed Morphosyntax accounts. This more contemporary phonological work then provides a way of comparing theories with the earlier phonology-only work. And as with any productive field of research, linguists have been able to adopt some of these views and investigate additional phenomena in more depth, specifically as it relates to interactions between phonology and allomorphy.

3.3.1 Early DM accounts

In part because the early works in Distributed Morphology emphasized the "syntax all the way down" nature of DM (Halle and Marantz, 1993; 1994), early DM accounts of NM tended to be concerned with NM systems as proof that roots could be abstract and quite small — the extreme version of this approach appearing in Marantz (1997) where the suggestion is made that

the word-formation processes seen in Semitic are in some ways more transparent views of word formation in DM than concatenative languages such as English. However, the central phonological puzzle in NM — how a concatenative syntax could force non-concatenative outputs — is largely shunted to "after morphology" in the phonological component. Discussions in this approach were framed around asking whether the phonology seen in NM should be modeled with post-syntactic readjustment rules or by some other means.

In a broad sense, this punting of phonological particulars is possible in DM because the syntactic focus on allomorphy defined in terms of locality and cyclicity does very well to capture some of the basic facts about Semitic morphophonology. The most important of these is arguably the "point of no return to non-concatenativity." Any syntactic material attached to the verb high enough in the structure is concatenative in Semitic, as seen in §2. What is important for theoretical accounts of NM phonology is that both of these classes of affixes leave the internal phonology of the base relatively undisturbed. In DM following Arad (2005), this is completely expected behavior given the cyclic boundary that is assumed to exist between Voice and the inflectional layer of the clause.[11] After Voice has merged, any DM-inspired account predicts that material inside VoiceP will be opaque to extreme forms of phonological non-concatenativity. DM, therefore, predicts the non-concatenative aspect of NM to track the argument-structure/inflectional bifurcation of the clause nearly for free. What is somewhat harder, however, is to understand what determines the non-concatenative behavior that exists at the level of VoiceP and lower.

As noted in §3.2.2, one of the earliest attempts to confront this problem appears in Arad (2005), where it was assumed that Vocabulary Insertion provides the non-concateantive behavior by treating templates as conjugation classes. While admirable in its attempt to confront the morphophonological problem posed by NM in DM, this approach does little more than stipulate the facts in Hebrew and requires language-specific conjugation classes instantiated as Vocabulary Items in ways that do little more than associate particular phonological readjustments to instances of v/Voice which happen to appear in particular derivations. There is little place in these theories for understanding why the NM patterns look the way they do in a given language.

3.3.2 NM as post-syntactic phonology

A current popular alternative to stipulating phonological effects in NM comes is to treat certain issues in morphophonology of inserted VIs in NM as a phonological concern, as in Tucker (2011a;b;c); Wallace (2013); and Kastner (2016; 2018). What unifies these approaches is the notion that phonological markedness constraint interaction paired with a consonantal root exponent for the syntactic root serves the engine of verb formation. In each of these approaches the syntax is interpreted by the morphological component, and what separates NM-containing languages from those without is a crucial ranking of some phonological markedness constraints above the faithfulness constraint CONTIGUITY (37).[12]

(37) CONTIGUITY:
The portion of the input standing in correspondence forms a contiguous string in the output.

[11] Note that this is true even under a C_1-LIN theory like that put forth in Embick (2010), since on that account elements in syntactic positions below Voice will have undergone Vocabulary Insertion before the addition of material in T or Neg/Σ.

[12] CONTIGUITY is likely properly formulated as a family of faithfulness constraints (McCarthy and Prince, 1995), but here we treat it as one constraint for the sake of exegesis.

If a language prizes enough phonological markedness constraints above CONTIGUITY, then exponents which serve as input to an Optimality-Theoretic phonology will surface discontinuously in the output rather than in one chunk (e.g. *ktb*). By attaching NM to the low-ranking of CONTIGUITY, these approaches predict there is "nothing special" about the phonology of NM except insofar as they are a typologically rare prediction of normal factorial typologies in Optimality Theory.[13] All that DM itself must furnish, therefore, is a collection of vocabulary items which account for morphosyntactic allomorphy.

Schematically, a sample derivation for *tarfa* 'she devoured' and *katva* 'she wrote' in Hebrew looks as follows on this account, abstracting away from the OT implementation of Kastner (2018). Here the stem vowels spell out Voice and affixes spell out higher material, which undergoes cyclic spell out. This means that the VoiceP level is subject to the following realizations int he vocabulary:

(38) *taraf* 'devoured':
- a. Voice ↔ *a,a* / T[Past] ___
- b. v ↔ (covert)
- c. $\sqrt{\text{trf}}$ ↔ *trf*
- d. $\sqrt{\text{ktb}}$ ↔ *ktb*

After this, a higher cycle and regular phonology interact to produce the desired output forms. The final /b/ of $\sqrt{\text{ktb}}$ spirantizes to [v], a regular phonological process in the language (Temkin Martínez and Müllner, 2016; Kastner, 2017; 2018). Next we see affixation of the 3SG.F suffix *-a* as well as a process of syncope, in which a vowel is deleted (annotated <*a*>), all portions which are dependent on the presence of T in the higher cycle. Recall once more that spell-out proceeds cyclically, first within the VoiceP domain and then within the TP domain. The result is the following complete derivations:

(39) T[Past, 3SG.F]-Voice-$\sqrt{\text{trf}}$, *tarfa* 'she wrote'
- a. $\sqrt{\text{trf}}$ ↔ *trf*
- b. Voice ↔ *a,a* / T[Past] ___
- c. *a,a-trf*
- d. OT evaluates possible outputs, violating CONTIGUITY and yielding (as opposed to *aatrf* or *trfaa*):
  /taraf/ ⇒ *taraf*
- e. T[Past, 3SG.F]-*taraf*
- f. 3SG.F ↔ *a* / Past ___
- g. *a-taraf*
- h. The phonology yields:
  /a-taraf/ ⇒ /tar<a>f-a/ ⇒ *tarfa*.

(40) T[Past, 3SG.F]-Voice-$\sqrt{\text{ktb}}$, *katva* 'she wrote'
- a. $\sqrt{\text{ktb}}$ ↔ *ktb*
- b. Voice ↔ *a,a* / T[Past] ___
- c. *a,a-ktb*

[13] We omit those constraint rankings here as their proofs are given in the works of Tucker (2011a;c); Wallace (2013); and Kastner (2018).

d. At this point the phonology spirantizes the /b/ and breaks up the contiguous string, yielding:
/katab/ ⇒ /katav/ ⇒ *katav*.

e. T[Past, 3SG.F]-*katav*

f. 3SG.F ↔ *a* / Past ___

g. *a-katav*

h. The phonology yields:
/a-katav/ ⇒ /kat<a>v-a/ ⇒ *katva*

The derivations above are based on the implementation in Kastner (2018), relying on many assumptions shared within this family of approaches, namely the interaction of a local, cyclic syntax to deliver vocabulary items which can be linearized discontinuously.

Where these approaches differ is in which phonological markedness constraints drive discontinuous realization. While all these theories recognize the action of constraints on maximal prosodic word size and the appearance of complex clusters, these alone are not sufficient to ensure the *particular* discontinuous realizations seen in particular NM languages. Tucker (2011a;c) argues that the crucial additional constraint aligns the root with the right edge of a prosodic word, Wallace (2013) suggests that the relevant constraints align morphemes to edges of words, and Kastner (2018) places the bulk of action in the avoidance of complex onsets. The difference here lies in what sort of information phonology has access to at the syntax-phonology interface — in Tucker's and Wallace's systems, some information from the morphological representation is present in the phonological system to identify roots in that module, whereas in the later work by Kastner (2016; 2018) the phonology primarily has access to phonological information and the notion of a stem.

3.3.3 The merits of phonological accounts

Obviously on heuristic or modularity grounds alone, approaches which dispensed with access to morphological structure at PF would be preferred, but work remains to be done to see if a purely phonological approach can attain maximal empirical coverage in all NM languages. The data examined in Wallace (2013) and Kastner (2016; 2018) do not include all the verbal forms seen in Arabic, and this language includes two verbal forms with identical syntax yet distinct morphophonology, namely *XaYYaZ* and *XaaYaZ*.[14] Both of these forms involve the addition of a single moraic unit — gemination of the medial root consonant in *XaYYaZ* and lengthening of the first vowel in *XaaYaZ*. Couching each either of these descriptive generalizations in a framework where phonology derives the entirety of NM effects arguably requires reference to morphological constituency to avoid generating *XaYYaZ* with roots that only appear in *XaaYaZ* and vice-versa. Perhaps here recourse to conjugation classes (§3.2.2) would be appropriate after all, though clearly this is a place where further work is needed.

More generally, approaches which assume that phonology underwrites non-concatenative phonology are well-suited to explaining the large correlation between languages which have NM and those which have strong phonological constraints on maximal prosodic word size and in this sense preserve the key insights of pre-DM phonology-only approaches to NM (McCarthy, 1979; 1981; Ussishkin, 2000; 2005; 2006; Graf and Ussishkin, 2002). Moreover, these accounts also provide an explanation for the suspicious correlation between languages with NM and languages which disallow or place heavy restrictions on complex syllable margins.

[14] For more on these forms and the particular challenges they pose for phonological accounts, see Moore (1990) and Tucker (2011a;c).

Combined with a morphosyntax that derives argument-structural allomorphy close to the root, these accounts can do away with the need for the template as a unit of theoretical analysis without needing to claim that the root is also not a primitive of word-formation.

3.4 Additional considerations and phenomena

The theoretical developments surveyed above have allowed researchers to engage with additional questions which go beyond the general setup of the morphological system, relying on existing technical machinery in order to analyze various puzzles linking phonology, morphology, syntax and semantics. We mention a number of these recent studies here, all of which build on the Current Consensus in (4).

Work by Faust (2012; 2016) contributes to the allomorphic discussion in its attempt to understand how the phonology of the root impacts the morphophonological derivation. He proposes a distinction between the phonological *index* of a morpheme—in essence a pointer to a lookup table—and the phonological *form*, which is listed segmentally. In particular Faust (2012) provides a DM-inspired analysis of Hebrew with special emphasis on understanding distinct patterns in vowel realization across three distinct classes of roots. This analysis proposes two distinct templatic positions which vowels can associate with in distinct morphological contexts. The analysis is then extended to /j/-final stems (one-half of the so-called WEAK VERBS where one of the root consonants is a glide), and it is concluded that the distinct vowel patterns with these stems is not a phonological reflex of the final vowel.

Responding then largely to claims that the grammar does not distinguish between distinct kinds of suppletive allomorphy, Faust (2016): argues that the morphophonology of Semitic systems requires distinguishing weak (i.e., partially phonologically similar) suppletion from strong (i.e., completely phonologically unpredictable) suppletion in analyses which follow particular assumptions common to DM-inspired work. Faust also argues that roots in Semitic are never wholly targeted by weak suppletion, with such processes instead only targeting particular root positions.

Faust's contributions are particularly noteworthy in that they introduce data from Semitic languages not often seen in this literature, especially Neo-Aramaic and South Arabian languages. For example, Faust and Hever (2010) and Faust (2019) explore various interactions between the Semitic root and affixal material which cannot be explained in purely surface terms. While the Current Consensus in (4) has been well-worked out with respect to Semitic languages with large numbers of speakers (e.g., Hebrew and Arabic), Faust remains one of a few researchers doing the important work of extending this understanding into less well-represented languages.

A different set of data is examined in work by Kramer (2014; 2015; 2016) which focuses on gender and takes Amharic as its main empirical domain. While space considerations keep us from being able to discuss the various phenomena at length, we can single out one representative contribution to NM debates. Kramer (2016) shows that the Semitic bifurcation of concatenative and non-concatenative affixation appears not only in the verbal domain as discussed earlier (§2) but also in the nominal domain. Roughly: in Amharic plural formation, there is a clear division between affixes which attach lower/earlier and cause idiosyncrasy and non-concatenativity and affixes which attach higher/later and are strongly compositional and concatenative. Strikingly, these affixes can co-occur on certain roots, leading to the phenomenon of DOUBLE PLURALS, perhaps familiar from loanwords in other Semitic languages (e.g. Hebrew *tʃips-im*, chips-PL, 'fries'). What is important in this work is that none of the machinery from the verbal domain needs to be seriously augmented to account for the nominal facts: low

plurals attach in the first cycle and have access to the root, whereas later plurals attach higher and do not. Kramer's work, therefore, draws a satisfying parallel between pluralization in the nominal domain and nominalization of verbs in the verbal domain.

In another line of syntactic-semantic work relying on DM analyses of NM, Ahdout (2019; In prep) undertakes a large-scale investigation of verbal nominalizations in Hebrew. Assuming the existence of functional heads such as Voice which are embedded under a nominalizer, Ahdout discusses a number of questions relevant to the syntactic and semantic properties of nominalization and cross-categorial derivations, including the status of the implicit external argument and the possible readings associated with a nominalized verb. Using Hebrew allows her to test claims from the general nominalization literature while identifying functional structure which in other languages might be expressed by silent affixes, but in Hebrew takes the form of NM. We take both Kramer and Ahdout's work to be the first step in a clear next direction for DM studies of NM: extending the insights of the Current Consensus to the nominal domain.

4 DM approaches to NM beyond Semitic

In Semitic languages like Hebrew most of the morphological system consists of NM, in particular the verbal forms. Because of this characteristic—and clearly because of relatively easy access to speakers, data and resources—Hebrew and Arabic have received most of the attention in analyses of NM within DM. Nevertheless, many other Semitic languages have important stories to tell, and many non-Semitic languages show NM in specific domains. Work on these lesser-studied languages is vitally important to understanding NM as a theoretical entity beyond the trappings of a single language family, so we use them to conclude our overview of contemporary analyses.

4.1 Template-based approaches

One of the best known examples of NM outside of Semitic can be found in a range of Yok-Utian languages including Yowlumne (also variably referred to as Yawelmani or Yolumni) and Sierra Miwok. In these languages, verbal forms can be descriptively modelled in terms of CV skeletons along the lines proposed for Semitic by McCarthy (1981) and discussed in §2.2.1.

Archangeli (1983:348) illustrates the NM forms of Yowlumne as in (41). Class 1 affixes have no influence on the form of the verb; it simply depends on the underlying representation of the root, e.g. Root 1b verbs are always CVVC(C) when combining with these affixes. But Class 2 affixes impose a specific template, regardless of the phonological shape of the root, e.g. Affix R verbs are always CVCVV(C).

(41) Archangeli's (1983) CV-Templates for Yowlumne:

		Root 1a	Root 1b	Root 1c
Class 1	Affix A	CVC(C)	CVVC(C)	CVCVV(C)
	Affix B	CVC(C)	CVVC(C)	CVCVV(C)
	...	CVC(C)	CVVC(C)	CVCVV(C)
Class 2	Affix P	CVC(C)	CVC(C)	CVC(C)
	Affix Q	CVVC(C)	CVVC(C)	CVVC(C)
	Affix R	CVCVV(C)	CVCVV(C)	CVCVV(C)

Up until recently, Archangeli's analysis which proposed these generalizations was one of the few thorough studies on NM in a non-Semitic language. While the bulk of the argumenta-

tion was aimed at substantiating the existence of the CV-template as a morpheme, this work served an important role historically: insofar as NM required language-specific theoretical mechanisms such as the CV-template *qua* morpheme (McCarthy, 1981), Archangeli's work served to show that the need for these mechanisms could be justified outside of Semitic. Moreover, several aspects of our Current Consensus in (4) appear in this work, including the suggestion that prosodic concerns influence templatic effects. In the continuation of this research program in Archangeli (1991), the advent of Prosodic Morphology allowed for additional insights which helped remove the stipulative nature of the CV-template, exactly as it did in Semitic. The general claim remained essentially the same, namely that morphological constraints require reference to a CV template which must be a morphological entity, because it is not the structure predicted by phonological markedness alone.

Recent work has, however, challenged the view from the early and Prosodic Morphology accounts that a CV template morpheme is needed to analyze Yok-Utian languages. The most in-depth analysis is probably that of Guekguezian (2017), a paper which represents a version of the modern consensus on non-concatenative effects as analyzed in DM-inspired approaches. Guekguezian argues that the Chukchansi dialect of Yokuts provides data demonstrating that templatic alternations are emergent on the interaction of local combinations of heads in the syntax subject to otherwise language-wide prosodic concerns in Yokuts. This analysis suggests that the prosodic requirement for well-formed prosodic words interacts with the cyclic nature of spell-out to derive Yokuts non-concatenative verbal morphology.

In Chukchansi, templatic morphology is triggered by only some suffixes (Class 1 vs Class 2 above), a difference attributed by Guekguezian (2017) to the characteristics of different syntactic heads. Furthermore, the templatic change applies only to some roots; Guekguezian argues that these roots are too light prosodically to form licit phonological words on their own.[15] The combination of these factors gives rise to templatic effects without templatic morphemes.

With regular (heavy) roots, regular affixation looks as follows, exemplified using the recent past suffix *-it* in (42) and the causative suffix *-la-* (together with tense) in (43). A regular process of hiatus resolution deletes the second of two adjacent vowels.

(42) Recent Past /-it/ and Hiatus Resolution:

a.	haj'k'it	CVCCVC	'finish'	/haj'k'it-it/	haj'.k'i.tit	'just finished'
b.	ʧ'edma	CVCCV	'think'	/ʧ'edma-it/	ʧ'ed.mat	'just thought'

(43) Causative /-la-/ and Hiatus Resolution:

a.	haj'k'it	CVCCVC	'finish'	/haj'k'it-la-it/	haj'.k'it.lat	'just made s.o. finish'
b.	ʧ'edma	CVCCV	'think'	/ʧ'edma-la-it/	ʧ'ed.ma.lat	'just made s.o. think'

Now, for light roots, recent past does not trigger a templatic form (44) but causative *-la-/-e-* triggers CVCVː, as in (45).

(44) Recent Past w/o Templates in Light Roots:

a.	wan	CVC	'give'	/wan-it/	wa.nit	'just gave'
b.	maːx	CVːC	'collect'	/maːx-it/	maː.xit	'just collected'
c.	ʔaml	CVCC	'help'	/ʔaml-it/	ʔam.lit	'just helped'

(45) Causative Still Has Templates in Light Roots:

g.	wan	CVC	'give'	/wan-la-it/	wa.naː.lat	*wan.lat	'just made s.o. give'
h.	maːx	CVːC	'collect'	/maːx-la-it/	ma.xaː.lat	*max.lat	'just made s.o. collect'
i.	ʔaml	CVCC	'help'	/ʔaml-e-it/	ʔa.maː.let	*ʔa.mil.lat	'just made s.o. help'

[15] In general, it is more appropriate to say that roots hold pointers to phonological information rather than having phonological content themselves. See Harley (2014), Kastner (2018), and especially Faust (2016).

What properties of roots and affixes derive these patterns? Guekguezian (2017) shows that the optimal foot in the language is iambic, such that the templatic shape is simply an ideal iambic foot. Roots like $\sqrt{\text{maːx}}$ 'collect' which cannot form an iamb are augmented to *ma.xaː*, giving the impression of the template CVCVː. This is why /wan/ is augmented to "templatic" [wa.naː], but /ʧ'edma/ can remain [ʧ'ed.ma].

The affixes which trigger this augmentation are then argued to be cyclic. As such, they trigger spell-out of their complement which includes the root. Importantly, the stem itself must be a valid phonological word in the language and if it does not meet the prosodic minimality requirements when it is spelled out, it gets augmented, meaning that only some affixes trigger augmentation, or templatic effects. Additionally, some non-triggering affixes are introduced higher in the structure and are non-cyclic, merging after the first cycle has been completed. As such, they cannot trigger prosodic minimality through augmentation. The net result of this interaction of cyclicity and prosodic minimality constraints is a system very similar in spirit to the Hebrew one, deriving NM without recourse to "templatic" morphology by way of intricate interactions between syntax, phonology and cyclic spell-out made up of the usual primitives of Distributed Morphology.

One important difference between Yokuts-style templatic morphology and the Semitic type outlined above is that the Yokuts templates are not associated with any syntactic or semantic information. However, in a DM-inspired approach to NM which leverages our Current Consensus (4), this difference should emerge as theoretically irrelevant — syntactic and semantic information is never associated with the template itself, but rather the functional heads which give rise to templatic effects when spelled out. Nothing about the architecture of DM approaches to NM requires that templatic shape be associated with consistent meaning (a feature of the theory, we think; see §3.2), and Chukchansi-like systems therefore pose no problem for DM, whereas theories which posit that templatic morphology are morphemes *sui generis* will require added stipulation to understand why Yokuts-style languages are seemingly different in this regard.

Regardless of whether or not Yok-Utian languages have precisely the same templatic NM system as Semitic, emerging re-analyses of familiar language families has also suggested that Semitic-style NM is not typologically unique. Some recent work claims that Semitic-style templates can be found outside of the Semitic language family, namely in Yucatecan Mayan (Lois and Vapnarsky, 2010; Lois, 2011). Lois' work suggests that in Yucatecan languages, roots contain small amounts of phonological material which undergo combinations of ablaut and affixtion as a result of expression in a locally verbal morphosyntax. Based on this work, Coon (2017) proposes that Mayan (and in particular Ch'ol) may show templatic affects: in places where a CVC verbal root appears with affixal vowel material, non-root material is argued to be the exponence of functional morphology. If correct, Coon's (2017) analysis of Ch'ol would further confirm that neither NM nor a fruitful DM approach to templatic effects is confined to Semitic. Moreover, this line work opens a door to a fascinating potential line of future inquiry: could the Current Consensus in DM (4) define the presence of NM in other languages not previously thought to contain theoretically significant NM?

4.2 Other NM effects and approaches outside Semitic

Templatic morphology of the Yokuts variety also famously appears in Sierra Miwok, one of the case studies examined by Bye and Svenonius (2012). These authors present a survey of various templatic and non-concatenative effects in various languages, which includes a unified view of metathesis, reduplication, infixation and templatic morphology, all of which can be

understood as concatenative syntax feeding a constraint-based phonology. This work represents an attempt to provide a proof-of-concept for the thesis that NM is epiphenomenal of (a) a properly-specified syntactic argument structure and (b) independently motivated prosodic and phonological constraints on individual languages. Using relatively simple syntactic and phonological assumptions, Bye and Svenonius (2012) argue that non-concatenative effects arise in a variety of distinct cases with distinct properties largely in the interaction of Minimalist syntax and Optimality-Theoretic phonology. Bye and Svenonius's (2012) work is arguably one of the first places where something like the Current Consensus in (4) is stated overtly and does a great service by relating this consensus to other morphophonological interactions (such as infixation and reduplication). However, this work is limited by its wide scope: because the chapter deals with such a large breadth of languages, it is difficult to assess the differential contributions of cyclicity, locality, and prosody, since both the syntactic and phonological analyses are based on as few assumptions as possible.

Sierra Miwok was also tackled by Zimmermann (2015), who demonstrated that a templatic effect can be seen as two different prefixes combining with a stem of certain phonological size: an empty mora or an empty segmental root node. This approach is in the general vein of Zimmermann's research program, which focuses on the phonology of NM. In a thorough OT account of continuative aspect in Upriver Halkomelem, Zimmermann (2013) shows clearly how assuming a specific representation for a supersegmental affix (in this case, a foot with unspecified segmental content) can be integrated straightforwardly into a concrete morphological system. As an upshot, various non-concatenative forms receive a unified analysis, one which does not posit any special non-concatenative processes.

And in a book rich in both data and analysis, Zimmermann (2017) combines her work on various non-concatenative phenomena across a range of languages, making a general point about what she calls "morphological length manipulation": templatic effects which cannot be explained by phonology alone or by morphology alone, but which require morphological triggering of language-specific phonological and prosodic constraints. The affixes which give rise to NM effects are predominantly modeled as "defective" or "floating" morphemes spelled out postsyntactically. The emphasis here is on the phonological analysis in terms of Containment and Color Theory, whereas less relies on the syntactic assumptions; the analysis is not couched in DM as such, although the decomposition of phonological words is compatible with DM and other distributed approaches. In any case, the resulting view of prosodically defective morphemes demonstrates once again how an OT grammar can incorporate concatenative morphology and produce the appearance of templatic phonology, in line with the overarching themes of all DM approaches. Moreover, this work may provide a foothold into some of the more recalcitrant phonological properties of templates that seemingly require access to cross-modular information (see the discussion in §3.3.2).

5 Syntax + DM + Phonology = NM

In this chapter we have surveyed work on NM in both the immediately pre-DM and DM frameworks and argued that the *gestalt* that emerges from this literature is that there is "nothing special" about NM; this is our Current Consensus, repeated here from (4) in §1:

(46) The Current Non-concatenative Consensus:
Non-concatenative morphology is not grammatically special except that it involves a particular combination of modular interactions that allow for non-concatenative phonology.

To summarize, the banality of NM emerges in this literature from an interaction of four key theoretical components: Firstly, cyclicity has been repeatedly argued to explain the relationship between non-concatenative morphology and syntactic properties typically taken to be argument-structural — NM is associated with argument structure because NM is related to the way v and Voice undergo VI close enough to the root to avoid cyclic opacity. Secondly, locality in allomorphy has been combined with cyclicity to predict that Voice, v and the root can exert allomorphic effects on one another in profound ways, and this has been argued to account for the rampant idiosyncrasy present in root/template interactions across NM languages as well as the generalization that NM idiosyncrasy can only occur so far up the syntactic structure. Thirdly, argument structure falls out of the particular combinations of syntactic heads present in typical DM fashion, tying not only allomorphy, but also valency, to the particular syntactic configurations out of which words are born. Finally, standard phonological theories have been devised to suggest that non-concatenativity is the natural interaction of a local, cyclic syntax with phonological systems which prefer phonologically unmarked forms over contiguous realization of input elements, an account which dovetails with phonologically inspired non-DM approaches, such as that of Bat-El (2008).

With all these positive components, there remain several outstanding questions which deserve consideration before DM could declare its approach to NM explanatorily adequate or complete. We suggest that these questions should be the focus of future work on NM in DM, especially when paired with research that broadens the empirical base for theorizing about NM beyond Hebrew and well-studied varieties of Arabic. We note a number of these before concluding.

Root meaning. What kind of information is encapsulated in a root, and how should this information by encoded formally? As discussed above, this issue is just as relevant to work on concatenative languages, but it does take center stage with NM due to the salience of the root across wordforms.

Phonological information. Precisely how much morphological information is required to be present at PF for an adequate theory of NM morphophonology? Even the most recent accounts require some kind of reference to morphophonlogical constructs such as stems. Can a phonological account do without any reference to stems or derivational history?

Cross-categorial derivations. Most formal work focuses either on verbs or on the phonology of nouns, with a few recent exceptions noted earlier. Yet even though DM prizes itself on deriving all wordforms from one underlying root, there is relatively little formal work investigating the consequences of cross-categorial derivations beyond denominal verbs.

NM crosslinguistically. Where exactly do we see NM outside of Semitic? Are there cases like Coon's analysis of Mayan that open up the Consensus to fruitful application in other languages? Are some corners of a given language more susceptible to NM than others? Why is there no attested "inverse Semitic system," where roots are made of vowels?

The syntactic primitives. What are the exact primitives needed for a DM account? To what extent can they be corroborated or informed by the large experimental literature such as the behavioral studies on roots by Ussishkin et al. (2015) and Deutsch and Kuperman (2018),

and on templates by Kastner et al. (2018) (see also the chapters on psycholinguistics and on neurlinguistics)?

Developmental studies. In the acquisition literature, Hebrew morphology is fairly well-represented (from Berman 1982 to Ashkenazi et al. 2016, with much additional work in between), but other NM languages less so (Ntelitheos and Idrissi, 2017). It remains an open question to what extent DM-based analyses can inform our understanding of the acquisition of NM. To the extent that formal work on NM has addressed acquisition, it remains at a general level such as unaccusativity or templatic alternations (Borer, 2004; Ravid et al., 2016; Kastner, 2016; Kastner and Adriaans, 2018), not requiring recourse to specific theoretical analyses and therefore unable to adjudicate between them or build on their insights; see also the chapter on acquisition.

We close by noting two places where we think that, despite outstanding questions, DM has added to the current understanding of NM by reformulating old debates in slightly more productive terms. More recent discussions in DM about the nature of the root yield a welcome outcome by suggesting that roots do not themselves contain phonological information but are instead pointers to phonological information. This allows DM to sidestep the question of "whether the consonantal root is real" in NM languages — a question which has preoccupied much of the non-DM literature for some time with little theoretical payoff. Treating concatenative and non-concatenative morphologies similarly means that roots are always the *sine qua non* of word-building, but take this place by virtue of their syntactic, not phonological properties. Pre- and non-DM systems which do not posit a central role for a generative syntax of roots are harder-pressed to adopt this conception of roots and its subsequent easing of the tension between the phonological expression of roots in NM and non-NM languages.

Moreover, the syntactic approach inherent in DM accounts of NM also obviates much of the debate on whether word-formation in NM languages is "root-" or "word-" based. While much of the phonological and pre-DM morphological literature on DM has debated whether all word formation should begin with the root, DM accounts have as a matter of theoretical hypothesis the notion that word-formation takes as input whatever the syntax can generate. Since it is a well-established fact that, for instance, the syntax can nominalize complex constituents, it is not surprising that denominal verbs show morphophonological and morphosyntactic properties that suggest that they are derived from an underlying verb — these are precisely the sorts of effects that motivated the syntactic approach to argument structure in the first place.

Stepping back from NM, it is clear that in Distributed Morphology, the syntactic and phonological elements necessary are the same theoretical pieces responsible for explanations of *concatenative* morphology — cyclicity and locality interact to restrict allomorphy to adjacent or near-adjacent syntactic elements, which themselves yield systematic semantic interpretations. Phonology then interprets the syntactic output with respect to language-particular phonological considerations. This is, we think, the most welcome result of the Current Consensus — concatenative and non-concatenative systems are cut from the same theoretical cloth, differing only in language particular properties of vocabulary items and phonological constraint ranking. One might even say that Distributed Morphology would, when paired with current phonological theories, be hard-pressed to explain the *absence* of NM systems, were that the typological reality. We consider this a welcome result and look forward to seeing how future work adopting the Current Consensus can further broaden our understanding of morphology in general.

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